



# Open Research Online

---

The Open University's repository of research publications  
and other research outputs

## Potential legal implications of advances in neuroimaging techniques for the clinical management of patients with disorders of consciousness

### Book Section

#### How to cite:

Pywell, Stephanie (2015). Potential legal implications of advances in neuroimaging techniques for the clinical management of patients with disorders of consciousness. In: Sturma, D.; Honnefelder, L. and Fuchs, M. eds. Jahrbuch für Wissenschaft und Ethik. Band 19. Berlin: De Gruyter, pp. 115–146.

For guidance on citations see [FAQs](#).

© 2015 Walter de Gruyter GmbH

Version: Accepted Manuscript

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.1515/jwiet-2014-0110>

---

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

---

[oro.open.ac.uk](http://oro.open.ac.uk)

**POTENTIAL LEGAL IMPLICATIONS OF ADVANCES IN NEUROIMAGING TECHNIQUES  
FOR THE CLINICAL MANAGEMENT OF PATIENTS WITH DISORDERS OF CONSCIOUSNESS**

**Dr Stephanie Pywell, The Open University Law School, England**

**INTRODUCTION**

Voluntary communication with others is a fundamental characteristic of human beings. It serves myriad purposes, and depriving someone of the ability to communicate by gagging and isolation has long been recognised as a harsh form of punishment. This paper considers whether recent developments in neuroimaging, and the United Kingdom's legal obligations, particularly those arising under human rights treaties, could combine to require greater efforts to be made to enable people whom serious brain damage has rendered unable to communicate by conventional methods to make their wishes and feelings known.

Most adult patients are able to inform clinicians when they are in pain or distress. Patients who are unable to speak may exhibit non-verbal forms of communication – such as responsive tears or an involuntary reaction to palpation – that can be the trigger for overt sympathy or the administration of pain-killers. People suffering from the disorders of consciousness (DoCs) – coma, vegetative state (VS) and minimally conscious state (MCS) – are usually unable to communicate verbally or non-verbally, and the traditional view has been that such patients cannot make their feelings and wishes known. In a fourth condition, locked-in syndrome (LIS), patients are fully conscious but almost completely paralysed,

and hence unable to respond to most stimuli, but they may be able to communicate via tiny movements, usually of the eyes or eyelids.<sup>1</sup>

Several studies have suggested that a significant number of patients are misdiagnosed as having a more severe DoC than is actually the case, meaning that their already profound suffering may be exacerbated by their being inappropriately treated as though they were unconscious. Recent advances in the use of neuroimaging techniques including electroencephalograms (EEGs), functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) potentially offer a means of enabling some MCS patients, and LIS patients who are totally paralysed, to communicate. If neuroimaging techniques could be refined and made available to assess all patients with DoCs, physicians would have another potential means of confirming diagnoses that had been reached by conventional means. Further development of some recently developed neuroimaging paradigms could potentially enable doctors to ascertain whether some patients with DoCs were in pain and, if so, whether and how they would like it to be treated.

This paper outlines the DoCs and reviews some important neuroimaging studies on patients who suffer from them. It goes on to discuss whether, in the future, doctors could be under an ethical duty to use neuroimaging techniques to assess all such patients and to endeavour to facilitate communication by some patients. It concludes with consideration of whether the UK's accession to the European Convention on Human Rights and the United Nations Convention on the Rights of Persons with Disabilities could eventually mean that its emanation, the National Health Service (NHS), could be deemed to have a legal duty to exploit neuroimaging techniques in order to improve the psychological and physical care afforded to some of its most vulnerable adult citizens.

---

<sup>1</sup> JB Posner and others, 'Plum and Posner's diagnosis of stupor and coma' (Oxford University Press: New York, 4th edn, 2007).

## CLINICAL CONSIDERATIONS

### *Signs of consciousness*

Consciousness is vital to most people's understanding of what it is to be human, but there is no completely satisfactory, universally accepted definition of it.<sup>2</sup> It has been defined as including minimal sentience and the capacity to experience suffering.<sup>3</sup> Many sources regard it as denoting knowledge and awareness of oneself and the environment,<sup>4</sup> and view it as consisting of two components: wakefulness and awareness.<sup>5</sup> Wakefulness occurs when a person's eyes are open and his or her brain is emitting a predictable pattern of electrical activity; awareness, because of its subjective nature, is much more difficult to determine by pure observation, and relies on a positive response from the individual.<sup>6</sup> In people who are completely paralysed – and hence wholly unresponsive to standard clinical instructions such as 'blink' or 'squeeze my hand' – the only way that such a response may be elicited is via neuroimaging.

### *Disorders of consciousness*

---

<sup>2</sup> S Laureys, F Perrion, S Bredart, 'Self-consciousness in non-communicative patients' (2007) *Conscious Cogn.* 16(3), 722–41.

<sup>3</sup> DJ Wilkinson and others, 'Functional neuroimaging and withdrawal of life-sustaining treatment from vegetative patients' (2009) *J. Med. Ethics* 35, 508–511.

<sup>4</sup> JB Posner and others, 'Plum and Posner's diagnosis of stupor and coma' (Oxford University Press: New York, 4th edn, 2007).

<sup>5</sup> S Laureys, F Perrion, S Bredart, 'Self-consciousness in non-communicative patients' (2007) *Conscious Cogn.* 16(3), 722–41.

<sup>6</sup> AM Owen, 'Detecting Consciousness: A Unique Role for Neuroimaging' (2013) *Annual Review of Psychology* 64, 109–133.

Three DoCs are diagnosed and mutually differentiated, with some difficulty, by established criteria.<sup>7, 8</sup>

All of them can be brought about by traumatic brain injury such as a blow to the head, an organic illness such as meningitis, a stroke or an episode of anoxia. They are outlined below in decreasing order of severity.

A deep coma is characterised by a complete absence of unaided eye-opening and voluntary movement; patients' only motor responses are reflexes.<sup>9</sup> A diagnosis is reached if there is a 40–50% loss of brain metabolic activity lasting at least an hour.<sup>10</sup> This condition is usually transient, though it must last at least six hours<sup>11</sup> and most patients progress to VS or MCS within a few weeks.<sup>12,13</sup> Medically induced comas, such as the one effected in December 2013 to facilitate the recovery of former Formula One champion, Michael Schumacher, can last for longer periods of time, but an increased duration of complete unconsciousness increases the probability of significant residual damage.

Patients in VS have periods of apparent sleep and wakefulness, because they open and close their eyes in a cyclical way.<sup>14</sup> They may moan, smile or even utter occasional single words, but all these actions are thought to be involuntary<sup>15</sup> and there is no evidence that they are aware of themselves or their

---

<sup>7</sup> S Laureys, AM Owen, ND Schiff, 'Brain function in coma, vegetative state, and related disorders' (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>8</sup> C Schnakers, J Giacino, S Laureys, 'Coma: Detecting signs of consciousness in severely brain injured patients recovering from coma' in JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2010).

<sup>9</sup> *Ibid.*

<sup>10</sup> *Ibid.*

<sup>11</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>12</sup> S Laureys, AM Owen, ND Schiff, 'Brain function in coma, vegetative state, and related disorders' (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>13</sup> C Schnakers, J Giacino, S Laureys, 'Coma: Detecting signs of consciousness in severely brain injured patients recovering from coma' in JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2010).

<sup>14</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>15</sup> C Schnakers, J Giacino, S Laureys, 'Coma: Detecting signs of consciousness in severely brain injured patients recovering from coma' in JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2010).

surroundings.<sup>16,17</sup> They are doubly incontinent.<sup>18</sup> They may grind their teeth, roll their eyes or shed tears, but all these actions appear to be spontaneous rather than responsive. The pejorative connotations of the word ‘vegetative’ led to a proposal that VS be re-named ‘unresponsive wakefulness syndrome’ (UWS),<sup>19</sup> but most studies still refer to ‘VS’, and the Royal College of Physicians (RCP) prefers this term because ‘UWS’ has not been fully defined.<sup>20</sup>

MCS was defined as being a state with a diagnosis distinct from that of VS in 2002.<sup>21</sup> MCS may be diagnosed if the patient can consistently follow simple commands, articulate or indicate positive and negative responses (irrespective of accuracy), speak intelligibly or exhibit purposeful behaviour such as reaching out in the direction of an object.<sup>22</sup> Emotional responses such as crying and smiling can be elicited by environmental triggers, and patients’ eyes have been observed as following things.<sup>23</sup> MCS can be a stage of the recovery from coma to consciousness – in which case it can be termed ‘transient MCS’ – and people are deemed to have emerged from it if they can answer six simple ‘yes’/‘no’ questions correctly on two consecutive assessments, or if they can correctly use – or attempt to use – two different objects, such as a comb or pencil, on two consecutive evaluations.<sup>24</sup> In 2011, MCS was sub-classified into MCS+ and MCS– : patients in the former state are able to follow commands, speak

---

<sup>16</sup> S Laureys, AM Owen, ND Schiff, ‘Brain function in coma, vegetative state, and related disorders’ (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>17</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>18</sup> Royal College of Physicians, ‘The Vegetative State: Guidance on diagnosis and management’ (RCP: London, 2003). <https://www.rcplondon.ac.uk/sites/default/files/documents/vegetative-state.pdf>.

<sup>19</sup> S Laureys and others, ‘Unresponsive wakefulness syndrome: a new name for the vegetative state or apallic syndrome’ (2010) *BMC Medicine* 2010 8, 68.

<sup>20</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>21</sup> JT Giacino and others, ‘The minimally conscious state: Definition and diagnostic criteria (2002) *Neurology* 58 (3), 349–353. <http://www.neurology.org/content/58/3/349.full>.

<sup>22</sup> *Ibid.*

<sup>23</sup> C Schnakers, J Giacino, S Laureys, ‘Coma: Detecting signs of consciousness in severely brain injured patients recovering from coma’ in JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2010).

<sup>24</sup> JT Giacino and others, ‘The minimally conscious state: Definition and diagnostic criteria (2002) *Neurology* 58 (3), 349–353. <http://www.neurology.org/content/58/3/349.full>.

intelligibly and indicate ‘yes’ or ‘no’, while those in the latter state are able only to identify the location of a source of discomfort, follow objects with their eyes, cry or smile responsively and reach, touch or hold objects.<sup>25</sup>

VS and MCS can be enduring states, and their duration provides a basis for sub-classification. It was suggested that VS be characterised as ‘persistent’ if it lasted for more than one month and ‘permanent’ if it lasted more than three months or were deemed to be irreversible.<sup>26, 27, 28</sup> This terminology has not been consistently adopted, and the RCP has pointed out the potential confusion because both sub-classifications could be abbreviated to ‘PVS’. It therefore proposes the use of ‘continuing’ to denote a state of VS or MCS that has existed for four weeks or more. ‘Permanent’ would be used for a VS of at least six months’ duration if it were caused by anoxia or a metabolic brain injury, and at least 12 months’ duration if it were caused by a traumatic injury. MCS would be ‘permanent’ if it had lasted at least five years or, in some specified circumstances – such as having been triggered by protracted anoxia – three years, after which a return to consciousness is deemed very improbable.<sup>29</sup>

Patients with LIS are fully conscious but behaviourally unresponsive due to paralysis. Some of them are able to establish reliable, if painstakingly slow, means of communication with their clinicians and carers, but there are concerns that approximately 40% of LIS patients are not recognised as being conscious or able to communicate, and the percentage is likely to be higher in ‘total LIS’ patients who are unable to

---

<sup>25</sup> Marie-Aur lie Bruno and others. ‘From unresponsive wakefulness to minimally conscious PLUS and functional locked-in syndromes: recent advances in our understanding of disorders of consciousness’ (2011) *Journal of Neurology* 258(7), 1373-1384.

<sup>26</sup> Multi-Society Task Force on P.V.S., ‘Medical Aspects of the Persistent Vegetative State (2)’ (1994) *New Engl. J. Med.* 330, 1572-1579.

<sup>27</sup> S Laureys, AM Owen, ND Schiff, ‘Brain function in coma, vegetative state, and related disorders’ (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>28</sup> C Schnakers, J Giacino, S Laureys, ‘Coma: Detecting signs of consciousness in severely brain injured patients recovering from coma’ in JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2010).

<sup>29</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

move even their eyes or eyelids.<sup>30, 31</sup> As was illustrated by the highly publicised case of Tony Nicklinson,<sup>32</sup> some LIS patients – even those who have devoted and compassionate carers with whom they can communicate – find their situation unbearable because they are fully conscious of their helplessness and indignity. One can only imagine the degree of distress experienced by those in total LIS. The plight of these patients highlights the need for diagnostic accuracy: if total LIS can be mistaken for MCS – or even VS – it is possible that patients with no cognitive impairments overhear doctors discussing them as if they were, quite literally, not there.

### *Diagnostic challenges*

Accurate diagnostic differentiation between the DoCs, which is reached by detecting signs of consciousness, is acknowledged as being challenging.<sup>33, 34</sup> It has been suggested that more comatose patients than formerly believed may regain some signs of consciousness.<sup>35</sup> One study found that 43% of 40 patients admitted to a rehabilitation unit had been misdiagnosed as being in VS, and a further 33% of the 40 patients slowly emerged from VS.<sup>36</sup>

The RCP recognises that misdiagnosis of DoCs is ‘a significant problem’, and recommends that diagnosis should occur after ‘evaluation by a multidisciplinary team of clinicians’ using ‘both detailed clinical

---

<sup>30</sup> AM Owen, MR Coleman, ‘Functional Neuroimaging of the Vegetative State’ (2008) 9 Nat. Rev. Neurosci. 235–243.

<sup>31</sup> C Schnakers and others, ‘Detecting consciousness in a total locked-in syndrome: an active event-related paradigm’ (2009) Neurocase 15, 271–277.

<sup>32</sup> *R. (on the application of Nicklinson) v Ministry of Justice; R. (on the application of A.M.) v Director of Public Prosecutions and others* [2012] EWHC 2381 (Admin)

<sup>33</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>34</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) Lancet 384 (9942), 514–522.

<sup>35</sup> S Laureys and others, ‘Unresponsive wakefulness syndrome: a new name for the vegetative state or apallic syndrome’ (2010) BMC Medicine 2010 8, 68.

<sup>36</sup> K Andrews and others, ‘Misdiagnosis of the vegetative state: retrospective study in a rehabilitation unit’ (1996) BMJ 313, 13–16.



evaluation and validated structured assessment tools'.<sup>37</sup> Because of the inconsistency inherent in MCS patients' responses, the structured assessments should be repeated about 10 times over a two- or three-week period.<sup>38</sup> This approach maximises the chances of gaining insight into the various factors that may mask or prevent patients from indicating that they are minimally conscious.

### *The significance of diagnosis*

It is difficult to overstate the importance of accurate diagnosis: the label of VS or MCS affects clinical decisions, treatment planning and, potentially, decisions to withdraw treatment and allow a patient to die.<sup>39, 40</sup>

In *Airedale NHS Trust v Bland*<sup>41</sup> the High Court ruled, and the Court of Appeal affirmed, that the withdrawal of artificial nutrition and hydration (ANH) would be in the best interests of Tony Bland, who had been in PVS for over three-and-a-half years. In the House of Lords, which unanimously upheld the judgments of the lower courts, Lord Mustill observed (at 899):

... I still believe that the proposed conduct is ethically justified, since the continued treatment of Anthony Bland can no longer serve to maintain that combination of manifold characteristics which we call a personality ... I have no doubt that the best interests of Anthony Bland no longer

---

<sup>37</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013) at pp. 14, 16.

<sup>38</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013)

<sup>39</sup> S Laureys, AM Owen, ND Schiff, 'Brain function in coma, vegetative state, and related disorders' (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>40</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>41</sup> [1993] A.C. 789, [1993] 2 W.L.R. 316.

demand the continuance of his present care and treatment. This is not at all to say that I would reach the same conclusion in less extreme cases, where the glimmerings of awareness may give the patient an interest which cannot be regarded as null.

The difference between VS and MCS can be regarded as the ‘glimmerings of awareness’ to which Lord Mustill referred and, since *Bland*, the UK courts have generally permitted the withdrawal of ANH from patients in VS, but not from those in MCS. The latter practice was evident in the High Court’s decision in *W. v M.*,<sup>42</sup> where the patient had been diagnosed as being in MCS; experts differed as to whether she was at the higher level within this condition, or at the boundary between MCS and VS. Several members of the patient’s close family asserted that she had formerly made it known that she would not have wished to be kept alive in such circumstances, but Baker J. (at para 221) ordered that ANH be continued on the basis that it was in the patient’s best interests. He described the patient thus:

She is sensate, clinically stable, aware of herself and her environment, able to respond to people, and to music, and also, in a very limited way, to communicate about her needs. In short, she is recognisably alive in a way that a patient in VS is not.

The term ‘recognisably alive’ is another vivid indicator of the difference between VS and MCS: by implication, people in VS are regarded almost as though they were dead. This emphasises the crucial importance of not misdiagnosing a patient as being in VS when he or she may have even the slightest ‘glimmering of awareness’.

---

<sup>42</sup> [2011] EWHC 2443.

The courts' different approaches to the withdrawal of ANH in patients in VS and MCS were highlighted in *An NHS Trust v J.*<sup>43</sup> where the patient had been diagnosed as being in VS. The High Court's approval of the application to withdraw ANH was delayed because of the Official Solicitor's concern – following the publication of a ground-breaking study in which fMRI had detected apparent consciousness in a patient who had been diagnosed as being in VS<sup>44</sup> – that the patient might in fact be in MCS.

Another powerful argument for accurate differentiation between the various DoCs is that the perception of pain appears to differ between patients in MCS and those in VS. One study found that the brains of patients in MCS process pain in a more integrated way: they responded similarly to those of healthy control subjects when the patients were subjected to electrical stimulation of the nerves in their wrists. Although no such responses were observed in patients in VS, the researchers were mindful of the limitations of their results, which had been based on group responses.<sup>45</sup> A study using a revised version of the Nociception Coma Scale – which relies on patients' observable motor, verbal and facial responses to unpleasant stimulation, such as pressure applied to the nailbed – yielded similar results. Using a responsiveness scale of 0–12 – between 0 and 3 marks were awarded for each of four subscores: the intensity of patients' motor, verbal and visual responses, and facial expressions – it was proposed that pain would be assumed to exist at a score of 4 for MCS patients, and 3 for VS patients. MCS patients' responses were in the range 2–8, while those for VS patients were in the range 1–4.<sup>46</sup> This suggests that, although it may be reasonable to regard patients in VS as being unable to feel pain, a different approach must be adopted towards those in MCS.

---

<sup>43</sup> [2006] EWHC 3152 (Fam.), [2006] All E.R. (D.) 73 (Dec.).

<sup>44</sup> AM Owen and others, 'Detecting awareness in the vegetative state' (2006) *Science* 313, 1402.

<sup>45</sup> M Boly and others, 'Perception of pain in the minimally conscious state with PET activation: an observational study' (2008) *Lancet Neurol.* 7, 1013–20.

<sup>46</sup> C Chatelle and others, 'A sensitive scale to assess nociceptive pain in patients with disorders of consciousness' (2012) *Journal of Neurology, Neurosurgery & Psychiatry* 83 (12), 1233–1237.

In *W. v M.*<sup>47</sup> an expert witness expressed her belief that the patient had hypersensitivity, and that she was experiencing significant discomfort and occasional pain, probably caused by her spasticity, joint deformities and double incontinence. Professional carers estimated that she was in pain about 25–30% of the time; her family thought she was in pain or discomfort more frequently. Baker J. concluded (at para. 232) that it was very difficult to determine whether a person in MCS was in pain and, if so, the extent of that pain. He concluded that the patient could feel pain, that she was sometimes in pain and sometimes not in pain, and held that these factors were part of the ‘balancing exercise’ that must be performed when considering whether to withdraw her ANH.

The usual causes of DoCs – sudden, intense impacts or medical conditions that cause severe inflammation or swelling of the brain – seem likely to be associated with chronic pain. The treatments – such as tube-feeding and ventilation – that are administered to many patients with DoCs are believed by some people to be burdensome and painful.<sup>48</sup> The consequences of prolonged incontinence and immobility, such as skin irritation and bedsores, are likely to cause serious discomfort. All these factors indicate that, if the condition of a person in a DoC is such that he or she can feel pain, there is a high likelihood that he or she does in fact feel pain.

There is now a widespread belief that people in MCS can experience pain; this has led to the assertion that: ‘we are invited to greater humility in discussing pain perception (and awareness more generally) in disorders of consciousness’.<sup>49</sup> It therefore seems clear that clinicians managing patients in MCS and VS should administer prophylactic analgesia when there is reason to suppose that a patient may experience a higher-than-usual level of pain. This would apply when a patient is undergoing planned surgery or an

---

<sup>47</sup> Above n. 42.

<sup>48</sup> L Skene and others. ‘Neuroimaging and the withdrawal of life-sustaining treatment from patients in vegetative state’ (2009) *Med.L. Rev.* 17(2), 245–261.

<sup>49</sup> A Demertzi and others, ‘Pain Perception in Disorders of Consciousness: Neuroscience, Clinical Care, and Ethics in Dialogue’ (2011) *Neuroethics* 6(1), 37-50 at p.44.

invasive treatment,<sup>50</sup> or when suffering from additional disorders such as dental abscesses or ingrowing toenails.<sup>51</sup> One commentator has suggested that people in MCS should be treated as though they were conscious, and hence should receive the same clinical support, including pain relief, as would be given to fully conscious patients.<sup>52</sup> This accords with the suggestion that all people who have phenomenal consciousness, which means that they can experience states such as pain and joy, should be regarded as ‘moral patients’ whose sentience means that there is a duty to minimise their suffering.<sup>53</sup> The cost of providing analgesia or anaesthesia when patients in MCS are undergoing procedures which would produce pain in healthy patients is low, particularly when set against the risk that non-provision could result in unnecessary suffering.<sup>54</sup>

## NEUROIMAGING

### *Techniques and their limitations*

The three most established neuroimaging techniques used in studies of people with DoCs are functional magnetic resonance imaging (fMRI), positron emission tomography (PET) scanning and electroencephalography (EEG). Diffusion tensor imaging (DTI) and functional near-infrared spectroscopy (fNIRS) also appear to have the potential to offer insights into the brain structure and function of such patients.

---

<sup>50</sup> M Boly and others, ‘Perception of pain in the minimally conscious state with PET activation: an observational study’ (2008) *Lancet Neurol.* 7, 1013–20.

<sup>51</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>52</sup> J Sleigh, CE Warnaby. ‘Functional brain imaging: gatecrashing the clinical party?’ (2014) *Lancet* 384 (9942) 476–477.

<sup>53</sup> N Levy, J Savulescu, ‘Moral significance of phenomenal consciousness’ in S Laureys, ND Schiff and AM Owen (eds), *Progress in Brain Research, Vol 177, Coma Science: Clinical and Ethical Implications* (Elsevier: The Netherlands, 2009), 361–370.

<sup>54</sup> J Whyte ‘Clinical implications of the integrity of the pain matrix’ (2008) *Lancet Neurology* 7(11), 979–980.

A scanner used in fMRI contains a powerful magnet, typically weighing around a ton, which measures the magnetic properties of oxygenated and deoxygenated blood. As the flow of blood to any part of the brain increases when that part is active, there will be both types of blood in all active regions. The scanner will indicate this fact, and the resulting image will indicate any regions of brain activity.<sup>55</sup> The process is non-invasive: unlike some types of scan, it does not involve the injection of any contrast agent. It has spatial and temporal limitations: the images reflect the blood flow to groups of several hundreds of thousands of neurons – nerve cells within the brain – whose activity cannot be differentiated from those of nearby neurons because they receive blood at the same time, and rapid changes in oxygenation are not identifiable because blood flows relatively slowly.<sup>56</sup> fMRI consists of a series of images taken every few seconds over 30 to 40 minutes while the subject is engaged in a particular activity, and analysis of the numerous sequential images takes place later, so the technique does not provide ‘real time’ data.<sup>57</sup>

There appear to be no concerns about the general safety of fMRI.<sup>58</sup> People can potentially be injured by loose ferromagnetic items that become airborne due to their magnetisation, and patients can suffer temporary hearing loss, the risk of which can be reduced by ear protectors, and excitation of peripheral nerves.<sup>59</sup> fMRI is not, however, suitable for everyone: patients with any kind of metallic implant cannot be scanned, and there are practical difficulties associated with patients who need frequent suctioning or

---

<sup>55</sup> W Glannon, *Bioethics and the Brain* (Oxford University Press: New York, 2006).

<sup>56</sup> G Rees, ‘The scope and limits of neuroimaging’ in *The Royal Society, Brain Waves Module 1: Neuroscience, society and policy* (The Royal Society: London, 2011).

<sup>57</sup> *Ibid.*

<sup>58</sup> US Food and Drug Administration, MRI (Magnetic Resonance Imaging ) (last updated 2014). Online: <http://www.fda.gov/radiation-emittingproducts/radiationemittingproductsandprocedures/medicalimaging/ucm200086.htm#rb>, accessed 9 October 2014.

<sup>59</sup> S Currie, ‘Understanding MRI: basic MR physics for physicians’ (2013) *Postgrad. Med. J.* 89, 209–223.

exhibit involuntary movements.<sup>60</sup> Being transferred to a scanner may be traumatic for patients,<sup>61</sup> and the results will be unreliable if patients are unable to keep still.

It is not currently practical to recommend fMRI as a routine clinical procedure<sup>62</sup>. Most, if not all, published studies are conducted by highly specialised teams working in carefully controlled conditions that would not easily be replicated in general hospitals,<sup>63</sup> and most MRI scanners are not currently operated by staff who have the expertise to administer and evaluate the necessary assessment paradigms.<sup>64</sup>

Most fMRI studies report the use of a 3-tesla MRI scanner, which costs a total of around £0.5 million to install in an existing scanner room, and scanning is logistically complex<sup>65</sup> and expensive: it cost around £500 per hour in 2011.<sup>66</sup> European Union health data indicated that, in 2011, there were an estimated 365 NHS-owned MRI scanner units in the UK<sup>67</sup>. In 2014, there were around 2,300 NHS hospitals in the UK,<sup>68</sup> suggesting that roughly one in every six hospitals has such a scanner. As the scanners are not easily portable, patients need to be taken to them. Although some MRI scanners may not have the

---

<sup>60</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>61</sup> AM Owen, 'Detecting Consciousness: A Unique Role for Neuroimaging' (2013) *Annual Review of Psychology* 64, 109–133.

<sup>62</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>63</sup> AM Owen, 'Detecting Consciousness: A Unique Role for Neuroimaging' (2013) *Annual Review of Psychology* 64, 109–133.

<sup>64</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>65</sup> J Stender and others, 'Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study' (2014) *Lancet* 384 (9942), 514–522.

<sup>66</sup> G Rees, 'The scope and limits of neuroimaging' in *The Royal Society, Brain Waves Module 1: Neuroscience, society and policy* (The Royal Society: London, 2011).

<sup>67</sup> Eurostat Data Explorer, Medical Technology: Magnetic Resonance Imaging Units in hospitals and ambulatory care providers (undated). The online statistical table from which this datum was taken was accessed, via a search of <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home>, on 7 May 2014. By 25 July 2014, the estimated figure had been removed from the table, and there were no data for the United Kingdom.

<sup>68</sup> NHS Confederation, Key statistics on the NHS (2014). Online: <http://www.nhsconfed.org/priorities/political-engagement/Pages/NHS-statistics.aspx>, accessed 9/10/14.

capacity to provide the detailed imagery necessary for fMRI, some modern 1.5T scanners can be used for fMRI.<sup>69</sup>

PET scanning is invasive: it involves injecting patients with a radioactive substance, commonly <sup>18</sup>F-fluorodeoxyglucose. The rate of radioactive decay indicates the rate at which the substance is being metabolised; this is generally proportional to the level of brain activity because active areas of the brain consume glucose more rapidly.<sup>70</sup> The main limitations of this technique are that images are taken roughly 30 seconds apart, so rapid changes are not detected, and the risks of radioactivity mean that only a small number of images can be produced for each patient.<sup>71</sup>

PET scanning involves some of the same practical difficulties as fMRI scanning: scanners cost around £4 million to buy<sup>72</sup> and are available only at larger hospitals and some research centres,<sup>73</sup> where each scan costs approximately £1,000<sup>74</sup>.

EEG collates data from a large number of electrodes that are stuck to a person's scalp to measure the difference in electrical potential that occurs when the large groups of neurons transmit information to adjacent brain cells. The results are recorded as visual traces on a graph-paper-style grid.

Electroencephalographs are inexpensive, widely available and typically small enough to fit on a bedside locker, and portable versions are used to record people's brain activity as they carry out their normal

---

<sup>69</sup> Siemens (undated). Online: <http://www.healthcare.siemens.co.uk/magnetic-resonance-imaging/0-35-to-1-5t-mri-scanner/magnetom-aera/use>, accessed 25 July 2014. The scanner in question is the Magnetom Aera, for which the 'Clinical use' tab mentions fMRI.

<sup>70</sup> J Stender and others, 'Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study' (2014) *Lancet* 384 (9942), 514–522.

<sup>71</sup> G Rees, 'The scope and limits of neuroimaging' in *The Royal Society, Brain Waves Module 1: Neuroscience, society and policy* (The Royal Society: London, 2011).

<sup>72</sup> Clinic Compare (undated). Online: <http://petscans.cliniccompare.co.uk/pet-scan-cost>, accessed 9 October 2014.

<sup>73</sup> NHS Choices, 'PET Scan: Introduction' (2013). Online: <http://www.nhs.uk/conditions/PET-scan/Pages/Introduction.aspx>, accessed 9 October 2014.

<sup>74</sup> Clinic Compare (undated). Online: <http://petscans.cliniccompare.co.uk/pet-scan-cost>, accessed 9 October 2014.



lives. EEG is non-invasive, and does not involve subjecting patients to any significant electrical or magnetic forces. EEG is more tolerant of patients' movements than are fMRI and PET, and a method has been proposed to separate EEG data that are due to head movements.<sup>75</sup> It has, however, been suggested that the quality of recordings may be adversely affected by patients' involuntary movements or other factors,<sup>76</sup> and abnormal EEG results can be difficult to interpret with certainty.<sup>77</sup>

DTI – which, like fMRI, is a variant of magnetic resonance imaging – senses the movement of water within the brain, mainly along the axes of bundles of the white matter that constitutes most of the brain. This can yield important information about the integrity of the brain's structure. One study reported that DTI could differentiate between MCS and VS patients with 95% accuracy, leading the researchers to claim that it may prove to be a very accurate method for diagnosing these two DoCs.<sup>78</sup> Since this technique involves magnetic resonance imaging, it seems inevitable that it will be subject to the same constraints as are fMRI and PET.

fNIRS relies on the fact that oxygenated and deoxygenated blood differ in the amount of near-infrared light that they absorb so, like fMRI, this technique provides a way of detecting the rate of blood flow in different regions of the brain.<sup>79</sup> It is able to penetrate to a depth of around 3cm, which includes the upper parts of the cortices.<sup>80</sup> The necessary equipment is portable, almost silent and suitable for

---

<sup>75</sup> S O'Regan, S Faul, W Marnane, 'Automatic detection of EEG artefacts arising from head movements' (2010) Engineering in Medicine and Biology Society, 2010 Annual International Conference of the IEEE. Online: <http://ieeexplore.ieee.org/xpls/icp.jsp?arnumber=5627282>, accessed 9 October 2014.

<sup>76</sup> Dorothée Lulé and others, 'Probing command following in patients with disorders of consciousness using a brain-computer interface' (2013) *Clinical Neurophysiology* 134, 101–106.

<sup>77</sup> AM Owen, 'Detecting Consciousness: A Unique Role for Neuroimaging' (2013) *Annual Review of Psychology* 64, 109–133.

<sup>78</sup> D Fernandez-Espejo and others, 'Diffusion weighted imaging distinguishes the vegetative state from the minimally conscious state' (2010) *Neuroimage* 54, 103–112.

<sup>79</sup> AM Owen, 'Detecting Consciousness: A Unique Role for Neuroimaging' (2013) *Annual Review of Psychology* 64, 109–133.

<sup>80</sup> *Ibid.*

patients who have metallic implants.<sup>81</sup> Its spatial resolution is better than that of EEG, and it has been shown in some studies to be an efficient way of detecting brain activity in non-responsive patients.<sup>82</sup> It is not yet established as offering a means of communication with patients diagnosed as being in PVS, but it seems to have significant potential.<sup>83</sup>

### *Some significant studies*

One fMRI study suggested that patients in MCS can experience some emotional responses that are similar to those in healthy individuals. Bekinschtein found that the amygdala – a centre of emotion in the brain – of a 17-year-old patient in transient MCS responded differently to recordings of his mother’s voice and a stranger’s voice.<sup>84</sup>

An fMRI study on healthy volunteers offers some insight into the effect of sedation on people’s response to words. Individuals’ brains were scanned when they were fully awake, lightly sedated and heavily sedated.<sup>85</sup> While they were in each of these states, the researchers played recordings of sentences that included ambiguous words, non-ambiguous sentences and non-verbal noise. Even under heavy sedation, the subjects showed brain responses to the sentences, but there was additional brain activity in the frontal and posterior temporal cortices – which constitute part of the higher-functioning grey matter of the brain – in response to the ambiguous sentences only when they were fully awake. This study suggested that, although some kinds of brain response to words can occur in the absence of consciousness, the cognitive processes that are required to interpret ambiguous sentences are impaired

---

<sup>81</sup> *Ibid.*

<sup>82</sup> *Ibid.*

<sup>83</sup> *Ibid.*

<sup>84</sup> T Bekinschtein and others. ‘Emotion processing in the minimally conscious state’ (2004) J. Neurol. Neurosurg. Psychiatry 75, 788.

<sup>85</sup> MH Davis and others, ‘Dissociating speech perception and comprehension at reduced levels of awareness’ (2007) Proc. Natl. Acad. Sci. USA 104(41), 16032–16037.

by sedation. This means that only studies that require patients deliberately to choose to think about something specific can be taken as indicating that they have a recognisable level of conscious awareness.

Owen reports that fMRI has identified signs of consciousness in some patients who had been diagnosed with VS. Two of 17 patients with this diagnosis were invited to visualise playing tennis and walking around their homes.<sup>86, 87</sup> This paradigm, which was chosen because the two visualisations activate different parts of the brain, had been validated on healthy volunteers.<sup>88</sup> Both patients who showed signs of consciousness had received the diagnosis of VS less than six months after suffering their brain injuries, which is the period when most changes occur. The study points out that, behaviourally, the diagnosis of VS was correct, and proposes a new term – ‘non-behavioural minimally conscious state’ or ‘non-behavioural fully conscious state’ – to cover patients whose consciousness is discernible only via fMRI. Both patients progressed to showing behavioural signs of MCS within a year of entering VS, which suggests that fMRI be useful in determining which VS patients may progress to MCS.

An fMRI study using a similar paradigm appeared to establish a means of eliciting responses from a patient who had been diagnosed with PVS. Fifty-four patients in VS or MCS were invited to visualise the activities specified by Professor Owen.<sup>89</sup> Five patients’ brains showed activity similar to that in healthy subjects engaged in the same visualisations, which was taken as an indication that they could wilfully modulate their brain activity. One of these patients had already been diagnosed with MCS. Of the four who had been diagnosed with PVS, two had already been found to have some signs of awareness. No

---

<sup>86</sup> AM Owen and others, ‘Detecting awareness in the vegetative state’ (2006) *Science* 313, 1402.

<sup>87</sup> AM Owen, MR Coleman, ‘Functional Neuroimaging of the Vegetative State’ (2008) 9 *Nat. Rev. Neurosci.* 235–243.

<sup>88</sup> M Boly and others, ‘When thoughts become action: An fMRI paradigm to study volitional brain activity in non-communicative brain injured patients’ (2007) *Neuroimage* 36, 979–992.

<sup>89</sup> MM Monti and others, ‘Willful Modulation of Brain Activity in Disorders of Consciousness’ (2010) *N. Engl. J. Med.* 362, 579–589.

sign of consciousness had been detected in the other two patients. Their responsiveness provided a mechanism via which they could potentially be invited to respond positively or negatively to questions, visualising playing tennis to indicate 'yes' and walking round their homes to indicate 'no' or *vice versa*. One of the unresponsive patients showed that he could use the visualisation technique to give correct answers to five out of six simple autobiographical questions – such as 'Do you have any brothers?'. He did not respond at all to the sixth question; the researchers noted that it was impossible to decide whether he fell asleep, did not hear the question, chose not to respond to it or lost consciousness. This patient had been repeatedly diagnosed with PVS, but behavioural re-assessment after the fMRI scan showed 'reproducible but highly fluctuating and inconsistent signs of awareness ... consistent with the diagnosis of a minimally conscious state'.<sup>90</sup> Despite the improvement in his condition, it remained impossible to establish two-way communication with him by normal bedside methods, so fMRI was the sole means by which he could be enabled to express himself.

A subsequent study indicates that it would be wrong to regard a patient as unconscious purely because of the non-production of meaningful fMRI results in response to requests to perform cognitive tasks. Researchers gave tasks of varying complexity to 14 healthy control subjects and six patients. They found that two patients in MCS and one in LIS demonstrated the anticipated patterns of brain activity when visualising playing tennis or swimming, but two patients with MCS and one who had emerged from MCS showed no such response. Only one of the three patients in the former group showed the expected pattern of brain activity when combining visualisation with the task of identifying her mother's name. In a more complex task involving identifying a previously memorised playing card, this patient gave discernible but incorrect responses. The researchers note that her positive responses appeared to be elicited by the options that were presented to her immediately after the correct options, and

---

<sup>90</sup> *Ibid.* at p. 585.

acknowledge the possibility that her clinical condition meant that she had attempted to respond to the correct option, but had been unable to do so within the 20-second interval allowed. The researchers suggest various interpretations of the results and conclude that ‘the most parsimonious choice ... is that Subject 1 was able to carry out the mental imagery to communicate’, indicating their confidence that her results were not a ‘false positive’. The study did, however, appear to produce ‘false negatives’: two patients who could respond accurately to the tasks using gestures or verbal communication did not produce detectable brain responses, even though they later indicated to the researchers that they had tried to perform the task. This led the researchers to conclude that their results pose ‘significant challenges’ to the prospect of using fMRI to communicate with DoC patients.<sup>91</sup>

In November 2012 it was widely reported that a 39-year-old Canadian man believed to have been in VS for 12 years was able, using the visualisation paradigm devised by Professor Owen, to inform doctors that he was not in pain.<sup>92</sup>

Although fMRI may potentially enable communication with DoC patients, its ability to enable them to indicate only positive and negative responses is limiting. It does not provide for the possibility of their asking questions, or of their giving an equivocal reply – such as ‘Don’t know’ or ‘Maybe’ – or any conditional response. The answers to any questions obtained in this way must therefore be interpreted in the light of each patient’s history and clinical condition; they cannot, given the current state of technology, constitute informed consent.<sup>93</sup> It has been argued that a simple ‘yes’ or ‘no’ response could not constitute evidence of informed consent because such consent requires the ability to discuss and

---

<sup>91</sup> Jonathan C. Bardin and others. ‘Dissociations between behavioural and functional magnetic resonance imaging-based evaluations of cognitive function after brain injury’ (2011) *Brain* 134 (3), 769–782.

<sup>92</sup> F Walsh, ‘Vegetative patient Scott Routley says “I’m not in pain”’ (2012) BBC News. Online: <http://www.bbc.co.uk/news/health-20268044>, accessed 9 October 2014.

<sup>93</sup> JJ Fins, ND Schiff. ‘In the Blink of the Mind’s Eye’ (2010) *Hastings Center Report* (May–June) 40(3), 21–23.

clearly express wishes about options.<sup>94</sup> Given that patients with DoCs may well have limited cognitive abilities, it would in any case be almost impossible to determine whether they fully understood the nature and quality of what they were being asked to consent to.

One EEG study showed that three out of 16 patients diagnosed with VS could generate regular P3 brainwaves, which denote cognitive processing, when asked to imagine moving their hand or toes, suggesting that, contrary to their diagnosis, they had some degree of consciousness.<sup>95</sup>

A further study by Cruse and colleagues suggested that the cause of the DoC may be a factor in determining whether observation and neuroimaging will lead to the same diagnosis. Twenty-three patients in MCS were asked to visualise movements of their fingers or toes, because the resulting EEG images would show whether they were able to follow simple commands. All five of the patients who followed the command had entered MCS following a traumatic injury. This suggests that there may be a higher level of cognitive functioning in patients whose brain injuries were caused by trauma rather than disease.<sup>96</sup> This is consistent with the fact that the chances of recovery are higher if the VS was triggered by a traumatic injury.<sup>97</sup>

---

<sup>94</sup> W Glannon 'Ethical issues with brain-computer interfaces' ( 2014) *Front. Syst. Neurosci.* 8, 136.

<sup>95</sup> D Cruse and others, 'Bedside detection of awareness in the vegetative state: a cohort study' (2011) *Lancet* 378(9809), 2088–94. The statistics that underlay this paper's findings were criticised as being invalid, because the results could have been affected by 'fluctuating artefact and arousal state' in patients, but not in healthy control subjects (Andrew M Goldfine and others, 'Reanalysis of 'Bedside detection of awareness in the vegetative state: a cohort study' (2013) *Lancet* 381 (9863), 289–291. The original authors defended their methods (Damian Cruse and others, 'Reanalysis of "Bedside detection of awareness in the vegetative state: a cohort study" – Authors' reply' (2013) *Lancet* 381 (9863), 291–292, indicating that there is still controversy about the robustness of at least some of the science on which these apparent advances depend.

<sup>96</sup> D Cruse and others, 'The relationship between aetiology and covert cognition in the minimally conscious state' (2012) *Neurology* 78, 816–22.

<sup>97</sup> Multi-Society Task Force on P.V.S., 'Medical Aspects of the Persistent Vegetative State (2)' (1994) *New Engl. J. Med.* 330 , 1572-1579.

EEG has been used to study the electrophysiological features of sleep in a small group of patients in MCS and VS. It was found that all six patients in MCS showed brain activity during sleep that mirrored that of healthy people – including, in five cases, periods of rapid-eye-movement (REM) and non-REM sleep. There was no such finding in the five patients in VS, although four of them had sustained periods during which their eyes were closed, thus giving the appearance of a normal sleep–wakefulness cycle.<sup>98</sup> This study suggests that measuring the electrophysiological features of sleep could be a useful way of differentiating between patients in MCS and those in VS.

A 2013 EEG study in which patients were asked to count the number of times that an experimenter said ‘yes’ or ‘no’, in a study where they also said ‘pass’ and ‘end’, yielded fairly consistent results in 14 out of 16 healthy control subjects, and results of potential interest for one out of two patients with LIS, one out of 13 patients in MCS and none of the three patients in VS.<sup>99</sup> The researchers concluded that it is currently impossible to determine whether EEGs offer a potentially useful means of communication with patients with DoCs, and suggest that studies should be conducted on patients with LIS, who are known to be conscious, in order to determine whether consciousness means that the patient can respond in such a way as to give positive results.

The relative reliability of PET and fMRI scanning in diagnosing MCS and VS, thereby providing more accurate prognoses, was assessed in 2014.<sup>100</sup> The 126 patients, whose scan results were compared with those of 39 healthy control subjects, had received settled clinical diagnoses of VS, MCS or LIS. Each patient had been diagnosed by the hospital that had referred them to University Hospital Liège, where

---

<sup>98</sup> E Landsness and others, ‘Electrophysiological correlates of behavioural changes in vigilance in vegetative state and minimally conscious state’ (2011) *Brain* 134, 2222–2232.

<sup>99</sup> Dorothée Lulé and others, ‘Probing command following in patients with disorders of consciousness using a brain–computer interface’ (2013) *Clinical Neurophysiology* 134, 101–106.

<sup>100</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) *Lancet* 384 (9942), 514–522.

the study took place, and by the Coma Recovery Scale – Revised (CRS–R), which is a detailed and reliable behavioural assessment tool. The PET scans measured glucose uptake in the areas of the brain associated with consciousness, notably the associative frontal-parietal cortices, and the fMRI scans were taken while patients were being asked to visualise playing tennis or walking round their homes; the results of either type of scan were omitted from the analysis if a patient moved too much. The prognostic accuracy of each type of scan was assessed against follow-up data obtained a year later, by which time several patients had died from causes apparently unrelated to their brain functioning. PET imaging results for 112 patients led to diagnoses that were consistent with those obtained using the CRS–R in 85% of patients, and correctly predicted outcomes in 74% of cases, with significantly greater reliability for negative outcomes (92%) than for positive outcomes (67%). fMRI results for 70 patients accorded with the CRS–R diagnosis in 63% of patients and correctly predicted outcomes in 56% of cases (63% correct for positive outcomes; 52% for negative outcomes). Both methods of neuroimaging detected brain activity in all the LIS patients, but PET scans showed 95% sensitivity to MCS, which was significantly higher than the level achieved by agreed clinical diagnosis (67%) or fMRI (45%), the latter having been confounded by a large number of false negatives. PET scans correctly predicted all the late recoveries of patients clinically diagnosed as being in VS, of whom four had been unresponsive for a year at the time of the assessment. It is suggested that these patients may in fact have been in ‘a border zone ... non-behavioural minimally conscious states could be used to characterise [their] clinical situation’.<sup>101</sup>

This study highlights the need for repeated standardised assessment tests, such as the robust and replicable CRS–R. The researchers acknowledge that fMRI remains a useful tool for identifying cognitive capacity, and that it is a potential tool for assisted communication, suggesting that PET and fMRI may have complementary roles in assessing patients with DoCs.

---

<sup>101</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) *Lancet* 384 (9942), 514–522 at p. 519.



It is impossible to eliminate all elements of subjectivity from the interpretation of neuroimaging results, and there are outstanding questions over the validity of some studies, particularly negative findings,<sup>102</sup> since about 20% of healthy volunteers do not generate discernible brain activity when undertaking imagery tasks.<sup>103</sup> A few patients whose behavioural diagnoses were that they were in MCS were identified by PET scans as being in VS, and a higher number of patients in MCS gave false negative results in fMRI scans.<sup>104</sup> This is powerful evidence that, assuming that the aim is to diagnose any trace of consciousness in order to offer patients appropriate care, neuroimaging must always be complementary to, rather than a substitute for, repeated testing with a robust assessment tool such as CRS–R.

The assertion made in 2004 by Steven Laureys, who is currently director of the Coma Science Group at the University of Liège – ‘Functional neuroimaging will never replace the clinical assessment of patients with altered states of consciousness.’<sup>105</sup> – probably remains true. Professor Laureys’ participation over the last decade in ground-breaking neuroimaging studies, including many of those identified in this paper, is nonetheless testament to his belief that such studies constitute a very useful tool for increasing our understanding of disorders of consciousness.

## POTENTIAL ETHICAL AND LEGAL IMPLICATIONS

### *Underlying ethical principles*

---

<sup>102</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) *Lancet* 384 (9942), 514–522.

<sup>103</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

<sup>104</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) *Lancet* 384 (9942), 514–522.

<sup>105</sup> S Laureys, AM Owen, ND Schiff, ‘Brain function in coma, vegetative state, and related disorders’ (2004) *The Lancet Neurology* 3(9), 537–546 at p. 544.

Doctors' duties, which are grounded in medical ethics, include taking 'all possible steps to alleviate pain and distress whether or not a cure be possible',<sup>106</sup> and avoiding harm, which can involve stopping, withdrawing or not starting treatment.<sup>107</sup> The requirement to respect patients' autonomy<sup>108</sup> is reflected in the duty to take account of patients' 'history (including the symptoms and psychological, spiritual, social and cultural factors), their views and values'.<sup>109</sup> These duties are as relevant to patients with DoCs as they are to fully conscious patients, so doctors should strive to fulfil them, even though they may never know with certainty whether they have succeeded; one commentator has expressly stated that doctors' ethical obligation to provide compassionate and empathetic care to all patients includes those who cannot report their pain.<sup>110</sup>

#### *The need for regular re-assessment*

It is essential that each patient's diagnosis continues to be correct; as discussed above, this has very significant implications for the treatment and care that are manifestations of the extent to which doctors have fulfilled their ethical duties. Clinicians acknowledge that they must re-assess DoC patients regularly in order to check whether their levels of consciousness have improved in ways that are not apparent by routine clinical observation. RCP suggests that an assessment of each patient should be carried out at least annually by specialised centres; at present there are inadequate resources to enable

---

<sup>106</sup> GMC. Good medical practice (GMC: London, 2013). Online: [http://www.gmc-uk.org/guidance/good\\_medical\\_practice.asp](http://www.gmc-uk.org/guidance/good_medical_practice.asp), accessed 9 October 2014, at Domain 1, para. 16(c).

<sup>107</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>108</sup> TL Beauchamp, JF Childress, Principles of Biomedical Ethics (Oxford University Press: New York, 7th edn, 2013).

<sup>109</sup> GMC. Good medical practice (GMC: London, 2013). Online: [http://www.gmc-uk.org/guidance/good\\_medical\\_practice.asp](http://www.gmc-uk.org/guidance/good_medical_practice.asp), accessed 9 October 2014, at Domain 1, para. 15(a).

<sup>110</sup> L Munglani, 'Pain perception in altered states of consciousness' (2013) Journal of Observational Pain Medicine 1(2).

this to occur.<sup>111</sup> The RCP Guidelines include a detailed structured approach to assessment<sup>112</sup> which assesses similar factors to those identified in the CRS–R. The study by Dr Stender and colleagues indicates that it would be preferable for annual reassessments to be carried out using the CRS–R, since this has a very high replicability between different clinicians and on different days.<sup>113</sup> If a patient shows some signs of being in MCS, but is unable to communicate by conventional means, it would be ideal if his or her cognitive functioning could be assessed via neuroimaging in order to avoid the despair that seems likely to engulf a conscious person who is unable to communicate. At present, logistical constraints make it impracticable for this to be standard practice, but the emergence of techniques such as fNRIS give grounds for hope that it may become possible to assess all patients by both structured assessments and neuroimaging techniques, in order to maximise the chances of identifying any signs of consciousness.

Regular re-assessment would indirectly benefit all patients with DoCs, because the resulting data could be used to develop a register of information about the number of people with DoCs and, in time, a database providing longitudinal data about the outcomes of DoCs.<sup>114</sup> These resources would provide concrete evidence that there is a need to establish additional ‘high-cost/low volume “specialised services”’, in keeping with the recommendations of the Carter report.<sup>115</sup> This would mean that staff with relevant expertise and experience could be concentrated in centres where patients with DoCs were

---

<sup>111</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>112</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. Electronic annex 2a: Full formal clinical assessment of people with PDOC. Online: [https://www.rcplondon.ac.uk/sites/default/files/annex\\_2a\\_full\\_formal\\_clinical\\_assessment.pdf](https://www.rcplondon.ac.uk/sites/default/files/annex_2a_full_formal_clinical_assessment.pdf), accessed 9 October 2014.

<sup>113</sup> J Stender and others, ‘Diagnostic precision of PET imaging and functional MRI in disorders of consciousness: a clinical validation study’ (2014) *Lancet* 384 (9942), 514–522.

<sup>114</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>115</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013) at p. 92.

treated, increasing the chances that patients would be physically close to scanning equipment and people who were able to operate it. The RCP acknowledges that this would be costly, but argues that the cost is justified because of the extreme vulnerability of patients with DoCs, their families' distress, and the potential cost savings in other acute care services.<sup>116</sup> Specialised centres could also carry out research in areas including neuroimaging which could potentially benefit significant numbers of people who have DoCs.

### *The importance of research*

The recognition that patients with DoCs cannot give informed consent to research has led to a suggestion that conducting research on such patients is unethical.<sup>117</sup> Against this must be set the fact that any treatment that such patients are receiving or have received is inevitably non-consensual. If they were found to be able to indicate simple responses via fMRI, an early question could be whether they consented to taking part in research and whether they wished their present treatment regime to continue. For reasons already discussed,<sup>118</sup> this would not constitute proper informed consent, but – at least arguably – it would be better than nothing.

It has been argued that such concerns can be overcome if one balances the ethical imperative of protecting non-communicative patients from harm with a recognition of the potential importance of research studies that increase the chances of diagnostic clarity, which carries the attendant possibility

---

<sup>116</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>117</sup> S Laureys, AM Owen, ND Schiff, 'Brain function in coma, vegetative state, and related disorders' (2004) *The Lancet Neurology* 3(9), 537–546

<sup>118</sup> Above n. 93 and n.94.

that some non-communicative patients may become able to express their own views.<sup>119</sup> It is unclear whether the patient who answered five out of six questions correctly by visualisation<sup>120</sup> would have been re-assessed so thoroughly using the established clinical methods had he not been taking part in the fMRI study. If not, he would have continued to be mis-labelled as being in PVS rather than MCS. If technological research is a trigger for detailed clinical re-assessment, it confers a benefit on patients in addition to, potentially, enabling doctors to respect the autonomy of these patients to a greater extent than is possible at present.

*Patients who (actually or ostensibly) lack mental capacity*

Some legal guidance as to the appropriate way of treating patients with DoCs can be found in the Mental Capacity Act 2005. This provides that ‘a person is assumed to have mental capacity unless it is established that he lacks capacity’ (subsection 1(2)), and that no-one should ‘be treated as unable to make a decision unless all practical steps to help him to do so have been taken without success’ (subsection 1(3)). It has been stated that: ‘By definition, a person in PDOC [persistent disorder of consciousness] will lack the mental capacity to make decisions regarding their welfare or treatment’.<sup>121</sup> I would argue that this is not necessarily the case: although people in MCS have suffered ‘an impairment of ... the mind or brain’ (subsection 2(1)), in the sense that they have lost the brain-driven ability to communicate, and are unable to communicate through normal means, they may not have the required inability to make decisions. This inability exists if the person cannot understand, retain, use or evaluate relevant information, or is unable to communicate the decision by ‘talking, using sign language or any other means’ (subsection 3(1)). If the neuroimaging techniques discussed above are eventually

---

<sup>119</sup> S Laureys, AM Owen, ND Schiff, ‘Brain function in coma, vegetative state, and related disorders’ (2004) *The Lancet Neurology* 3(9), 537–546.

<sup>120</sup> Above, n. 89.

<sup>121</sup> Royal College of Physicians, *Prolonged disorders of consciousness: National clinical guidelines*. (RCP: London, 2013).

developed to a point where they are robust and replicable by a significant number of centres and clinicians, it could be a breach of subsections 1(2) and 1(3) not to use them to attempt to determine whether patients with DoCs do have capacity. Neuroimaging techniques that can facilitate communication could fall within the ‘any other means’ specified in subsection 3(1). This means that techniques currently confined to research studies could ultimately be a key determinant of whether someone is deemed to have mental capacity.

The Act provides that decisions taken on behalf of those who lack capacity must be taken in the patient’s best interests, which’ includes considering ‘so far as is reasonably ascertainable ... the person’s past and present wishes and feelings’ (subsection 4(6)). This aspect of the determination of best interests was evident in the Supreme Court’s judgment in *Aintree University Hospitals NHS Foundation Trust v James*,<sup>122</sup> where Lady Hale stated (at para. 45) that the test of a patient’s wishes was subjective:

The purpose of the best interests test is to consider matters from the patient’s point of view ... Insofar as it is possible to ascertain the patient’s wishes and feelings, his beliefs and values or the things which were important to him, it is those which should be taken into account because they are a component in making the choice which is right for him as an individual human being.

A person’s past wishes and feelings may be ascertained from any oral or written statements made before the brain impairment occurred, and an indication of his or her current wishes and feelings might be ascertained by neuroimaging. *James* was applied in *Sheffield Teaching Hospitals NHS Foundation Trust v T.H. and T.R.*,<sup>123</sup> in which the Court of Protection had to decide whether it was in the best interests of T.H., a patient in MCS, to have life-sustaining treatment. Hayden J. stressed (at para. 56)

---

<sup>122</sup> [2013] UKSC 67.

<sup>123</sup> [2014] EWCOP 4.

that: 'whatever the ultimate weight to be given to TH's views it is important to be rigorous and scrupulous in seeking them out'. It can be argued that rigour includes affording patients all possible opportunities to communicate, but it is more likely that this would be interpreted as encompassing a requirement of reasonableness that would not extend to the current logistical and other difficulties involved in neuroimaging.

### *The possible relevance of human rights treaties*

Article 3 of the European Convention on Human Rights (ECHR) – which, at 15 words, is by far the shortest substantive Article – provides that: 'No one shall be subjected to torture or to inhuman or degrading treatment or punishment'. Like all the rights enshrined in the ECHR, Article 3 is – as Lady Hale (at para. 36) pointed out in *P. (by his litigation friend the Official Solicitor) v Cheshire West and Chester Council and another; P. and Q. (by their litigation friend, the Official Solicitor) v Surrey County Council*<sup>124</sup> (*Cheshire West* – universal in character and 'premised on the inherent dignity of all human beings whatever their frailty or flaws', so it applies equally to disabled and non-disabled people. Hohfeld's seminal analysis<sup>125</sup> provides that the jural correlative of an individual's absolute right is a state's absolute duty, which means that Article 3 imposes on all Contracting States an absolute duty to prevent their citizens from being subjected to torture or inhuman or degrading treatment. The absolute nature of the protection afforded by Article 3 is evident in a number of the European Court of Human Rights' (ECtHR) judgments, and no derogation from it is permitted, 'even in the event of a public emergency threatening the life of the nation' (*Ireland v United Kingdom*<sup>126</sup> at para. 163). It is therefore necessary to

---

<sup>124</sup> [2014] UKSC 19.

<sup>125</sup> WN Hohfeld, *Fundamental Legal Conceptions as Applied in Judicial Reasoning: And Other Essays*, WW Cook (ed). (Yale University Press: New Haven, 1964).

<sup>126</sup> (App. no. 5310/71) [1978] 2 EHRR 25.

consider whether leaving a minimally conscious person in unnecessary pain, or treating such a person as being in PVS, would be a breach of a Contracting State's duty under Article 3.

In two cases involving prisoners, the ECtHR has held that Article 3 includes a duty to treat pain. In *Kupczak v Poland*<sup>127</sup> the ECtHR held that it was a breach of Article 3 for the responsible authorities to fail to repair, over a period of two-and-a-half years, the morphine pump of a prisoner with chronic pain. In *Gurenko v Russia*,<sup>128</sup> the ECtHR stated (at para. 80) that ill-treatment in breach of Article 3 would involve 'a minimum level of severity [that] usually involves actual bodily injury or intense physical or mental suffering'. Part of the ECtHR's reasoning for holding that Article 3 had been breached was (at para. 88) that the prison authorities had 'failed to send the applicant to a cardiologist for an assessment and medical management of his serious condition'. This could be interpreted as suggesting that, in order to comply with the ECHR, all Contracting States are under a duty to assess and manage the pain of individuals whom they know, or believe, to be in pain.

Article 3 could also potentially be relevant to the argument that patients in MCS are undergoing a form of mental torture not experienced by those in VS, because the former group may be aware of their total dependence on others.<sup>129, 130</sup> It has been pointed out that the term 'minimally conscious' may be misleading, as patients may be fully able to experience sensations, even though their cognitive capacity is unclear.<sup>131</sup> This is a sobering thought: if patients in 'MCS' are actually fully conscious, with a degree of cognitive capacity, they may be deeply distressed at their plight yet wholly unable to communicate that

---

<sup>127</sup> (App. no. 2627/09) [2011] ECHR 127.

<sup>128</sup> (App. no. 41828/10) (unreported) 5 February 2013, ECtHR.

<sup>129</sup> Royal College of Physicians, Prolonged disorders of consciousness: National clinical guidelines. (RCP: London, 2013).

<sup>130</sup> LSM Johnson, 'The right to die in the minimally conscious state' (2011) J. Med. Ethics 37, 175–178.

<sup>131</sup> *Ibid.*



distress to anyone. Some neuroimaging studies suggest that people in MCS can experience emotion,<sup>132</sup> but a meta-analytical study of pain in people with DoCs concludes that it is uncertain whether the brain activity that has been observed really does indicate conscious emotion.<sup>133</sup> It has been argued that evidence that people in MCS can perceive pain and experience emotions gives rise to a moral duty to treat such patients.<sup>134</sup> If people in MCS are misdiagnosed as being in VS, and treated accordingly, this misdiagnosis would inevitably add to their suffering, and it is certainly arguable that this could feel like torture, despite its being inflicted inadvertently. It is established that Article 3 ECHR affords protection from psychological torture in circumstances where there is also physical suffering: in *Ilaşcu and others v Moldova and Russia*,<sup>135</sup> the ECtHR noted that an applicant's anguish was exacerbated by the arbitrary nature of his trial and the arbitrary exercise of powers relating to correspondence and visits during his detention. In *N. v United Kingdom*<sup>136</sup> (at para. 29), the ECtHR observed:

The suffering which flows from naturally occurring illness, physical or mental, may be covered by Article 3, where it is, or risks being, exacerbated by treatment, whether flowing from conditions of detention, expulsion or other measures, for which the authorities can be held responsible...

This express allusion to Contracting States' duty not to worsen the mental suffering of people who are ill certainly seems applicable to the situation that would arise if a person were incorrectly diagnosed by the NHS – an emanation of the state – as being without the 'glimmerings of awareness' to which Lord Mustill referred in *Airedale NHS Trust v Bland*<sup>137</sup>.

---

<sup>132</sup> Above, n. 84.

<sup>133</sup> A Demertzi and others, 'Pain Perception in Disorders of Consciousness: Neuroscience, Clinical Care, and Ethics in Dialogue' (2011) *Neuroethics* 6(1), 37-50.

<sup>134</sup> LSM Johnson, 'The right to die in the minimally conscious state' (2011) *J. Med. Ethics* 37, 175–178.

<sup>135</sup> (App. no. 48787/99) ECHR 2004-VII 179

<sup>136</sup> (App. no. 26565/05) ECHR 2008-III 227

<sup>137</sup> Above n. 41.

One potential avenue of redress for an MCS patient who was treated as being in VS or left in treatable pain because no-one had taken all possible steps to assess his or her condition or to attempt to ascertain his or her views would be a claim under Article 14 in conjunction with Article 3 ECHR. In practical terms, an action would have to be started by a litigation friend, who would need to argue that the patient's rights under Article 3 had been breached because of his or her disability; if the patient had been able to communicate easily with clinicians, they would have been aware of, and would presumably have treated, the pain. The ECtHR confirmed in *Glor v Switzerland*<sup>138</sup> that: 'there is no doubt that the scope of this provision includes discrimination based on disability' (at para. 80).

Although there are no readily identifiable cases where an applicant has linked disability discrimination contrary to Article 14 to a claim under Article 3, there are cases where claimants have linked Articles 3 and 14. This indicates that a combined claim could be advanced if someone's Article 3 rights were denied as a result of that person's disability. The applicants in *Pentiacova and 48 others v Moldova*<sup>139</sup> had renal failure, and so would be classified as disabled, but their claim for a violation of Article 14 in conjunction with Article 3 alleged discrimination on the basis of the place where they lived, rather than on their health status. The decision illustrates two rather surprising aspects of the ECtHR's approach. The first concerns the issues to be determined: the applicants had sought to discontinue their initial claim for a breach of their right to a private and family life under Article 8, but the ECtHR asserted its right to be 'master of the characterisation to be given in law to the facts of a case'. It considered and rejected the claim that the applicants' Article 8 rights had been violated by Moldova's failure to finance an optimal regime of haemodialysis, noting that Contracting States had a margin of appreciation in striking a balance between the competing interests of individuals and the community as a whole:

---

<sup>138</sup> (App. no. 13444/04) (unreported) 30 April 2009, ECtHR.

<sup>139</sup> (App. no. 14462/03) ECHR 2005-I 357.

While it is clearly desirable that everyone should have access to a full range of medical treatment, including life-saving medical procedures and drugs, the lack of resources means that there are, unfortunately, in the Contracting States many individuals who do not enjoy them, especially in cases of permanent and expensive treatment... the Court is of the opinion that in the circumstances of the present case it cannot be said that the respondent State failed to strike a fair balance between the competing interests of the applicants and the community as a whole.

(Sub-heading 'The law: B. Alleged violation of Article 8 of the Convention'.)

Article 8 is a qualified right; the derogations under Article 8(2) include 'the protection of the rights and freedoms of others'. This leads to the second interesting aspect: the ECtHR relied upon its dismissal of the Article 8 claim to dismiss without any discussion the applicants' claim that their absolute right to freedom from torture etc under Article 3 had been violated. It seems that the ECtHR takes a pragmatic view of Contracting States' resources, and is prepared to impose its view of the 'affordability' of a right – via consideration of a claim not even raised by the applicant – in order to defeat a claim for the violation of an absolute right.

In *N. v United Kingdom*<sup>140</sup> the ECtHR observed that 'inherent in the whole of the Convention is a search for a fair balance between the demands of the general interest of the community and the requirements of the protection of the individual's fundamental rights'. This case involved the right of an asylum-seeker to remain in order to continue to receive effective anti-retroviral therapy for Aids-related illnesses, and the ECtHR's judgment (at para. 24) suggests that her Article 3 right would not have been balanced against others' interests if she had been a UK national:

---

<sup>140</sup> Above n. 136.

The practical effect of extending Article 3 to cover the applicant's case would be to grant her, and countless others afflicted by Aids and other fatal diseases, a right to remain and to continue to benefit from medical treatment within a Contracting State. It was inconceivable that the Contracting States would have agreed to such a provision ... To enable an applicant to claim access to health care by the 'back door' of Article 3 would leave the State with no margin of appreciation and would be entirely impractical and contrary to the intention behind the Convention.

The United Kingdom is also a State Party to the United Nations Convention on the Rights of Persons with Disabilities (CRPD). Lady Hale pointed out in *Cheshire West* <sup>141</sup> (at para. 45) that CRPD is recognised by the ECtHR as being part of the international law within which the ECHR should be interpreted, and opined that it is 'axiomatic that people with disabilities, both mental and physical, have the same human rights as the rest of the human race'. CRPD includes several provisions that could be relevant to patients with DoCs. Article 4 1(g) provides that States Parties must undertake or promote the research and development of new technologies, including communications technologies that are suitable for people with disabilities. It could be argued that this includes neuroimaging, though it seems likely that, at present, such technology would fall foul of the requirement that priority be given to 'technologies at an affordable cost'. More abstract provisions are included in Article 12, whose title is 'Equal recognition before the law'. This provides (at 2) that people with disabilities have equal legal capacity with others, and (at 3) that States Parties must 'take appropriate measures to provide access by persons with disabilities to the support they may require in exercising their legal capacity.' These requirements could be interpreted as meaning that every State Party must do what it can to facilitate communication with

---

<sup>141</sup>Above n. 124.

disabled people who cannot use conventional means to make known their clinical needs and their wishes regarding treatment.

*Principles from UK case-law*

Most case-law involving patients with DoCs concerns the artificial prolongation of life. They are based on reasoning that is not directly relevant to the alleviation of psychological suffering or physical pain, but some elements of that reasoning are based on ethical principles that are equally applicable to those considerations.

In *NHS Trust A v M., NHS Trust B v H.*<sup>142</sup> Butler-Sloss P. held (at p. 813) that neither continuing nor withdrawing futile treatment could constitute torture or punishment. She further stated that Article 3 applied only to individuals who were either aware that they were being subjected to inhuman and degrading treatment or were 'in a state of mental or physical suffering' (at para. 49). She therefore concluded (at para. 49) that Article 3 was inapplicable to 'An insensate patient suffering from permanent vegetative state'. Recalling these *dicta* in *W. v M.*<sup>143</sup> (at para. 92), Baker J. stated that the increase in the medical understanding of VS that had occurred in the intervening decade meant that Butler-Sloss P.'s conclusion 'may ... not now be applied without qualification'. As discussed above, he went on to rule that the ANH of a patient in MCS should be continued, on the basis that it was in her best interests. Whatever one's view of Baker J.'s decision, the focus was, at least ostensibly, on what is best for the patient.

---

<sup>142</sup> [2001] 1 All E.R. 801.

<sup>143</sup> Above n. 42.

In *Airedale NHS Trust v Bland*<sup>144</sup>, some of the reasoning was based on interests that were not those of the patient. Lords Browne-Wilkinson and Mustill questioned (at A.C. pp. 879 and 896 respectively) whether it was appropriate to spend vast amounts of public money on keeping alive someone who was unaware of his own existence. Lord Mustill's remark came under a sub-heading 'Best interests of the community', which reflects the idea that social or distributive justice can be used as a rationale for allocating healthcare resources. Policy-makers generally favour large-scale, low-cost health interventions, rather than high-cost treatments that benefit a small number of individuals, so it is appropriate to consider whether such an approach would support neuroimaging of all suitable patients with DoCs and pain relief for those who were found to be able to communicate a need for it.

### *The cost-effectiveness of neuroimaging*

In the United Kingdom, quality-adjusted life-years (QALYs) constitute the criterion by which the National Institute for Health and Care Excellence (NICE) assesses the clinical effectiveness of treatments.<sup>145</sup> QALYs are a relative, rather than absolute, unit of measurement so, if the patient's life expectancy would not be predictably shortened by neuroimaging and the administration of pain-killing drugs, and the alleviation of pain would lead to an improvement in the quality of his or her life, the QALY would be a positive number. This is so even if the patient's quality of life – with and without pain relief – is rated as being worse than death.

The following example, which is a modified version of the one given on the NICE website, shows how the calculation would be made.

---

<sup>144</sup> Above n. 41.

<sup>145</sup> National Institute for Health and Care Excellence. 'Measuring effectiveness and cost effectiveness: the QALY' (2010). Online: <https://www.nice.org.uk/proxy/?sourceurl=http://www.nice.org.uk/newsroom/features/measuringeffectivenessandcosteffectivenessstheqaly.jsp>, accessed 9 October 2014.

Patient x is in a minimally conscious state.

- If he continues receiving no pain relief he will live for 5 years and his quality of life will be  $-1^*$  (0 or below = worst possible health, 1= best possible health)
- If he receives pain relief he will live for 5 years with a quality of life of  $-0.9$ .

The new treatment is compared with standard care in terms of the QALYs gained:

- No pain relief: 5 (years' remaining life)  $\times -1 = -5$  QALYs
- Pain relief: 5 (years' remaining life)  $\times -0.9 = -4.5$  QALYs
- Therefore, the new treatment leads to 0.5 additional QALYs (that is:  $-4.5$  minus  $-5$  QALYs =  $+0.5$  QALYs).
- The cost of pain relief is assumed to be £5,000, the alternative of no pain relief costs £0.

The difference in treatment costs (£5,000) is divided by the QALYs gained (0.5) to calculate the cost per QALY, so the new treatment would cost £10,000 per QALY.<sup>#</sup>

\* This presumes that being conscious, paralysed and in pain is the most undesirable situation imaginable, and is significantly worse than death; this is based on the fact that the High Court has repeatedly been called upon to determine whether it is lawful for some patients' lives to be ended at their own request.<sup>146</sup> This proposition is supported by the suggestion that sustaining the life of someone because they are discovered to be in MCS rather than PVS could be contrary to the patient's best interests because it could protract his or her period of suffering.<sup>147, 148</sup>

---

<sup>146</sup> See *R. (on the application of Nicklinson) v Ministry of Justice; R. (on the application of A.M.) v Director of Public Prosecutions and others* [2012] EWHC 2381 (Admin) (above n. 32) and *In re B. (Consent to Treatment – Capacity)* [2002] 1 FLR 1090.

<sup>147</sup> DJ Wilkinson and others, 'Functional neuroimaging and withdrawal of life-sustaining treatment from vegetative patients' (2009) *J. Med. Ethics* 35, 508–511.

<sup>148</sup> L Skene and others. 'Neuroimaging and the withdrawal of life-sustaining treatment from patients in vegetative state' (2009) *Med.L. Rev.* 17(2), 245–261.

# A treatment is generally not considered by NICE to be cost-effective if it costs more than £20,000–£30,000 per QALY, so this treatment would be considered cost-effective.

The life expectancy of five years and treatment cost of £5,000 are, in the absence of relevant data, very rough estimates. There are no collated statistics on the life expectancy of patients following a diagnosis of a DoC, but Cathy Kelly has been in PVS since 1989,<sup>149</sup> so five years could be a realistic figure for some patients, especially if the DoC had been caused by a traumatic injury. The cost of morphine for pain control in cases of advanced cancer is only £1.25 per patient per week,<sup>150</sup> but its use necessitates additional nursing care to monitor and alleviate such side-effects as nausea and constipation. The Quality, Innovation, Productivity and Prevention program estimates that the average cost of a hospital death, following palliative care, is £3,000,<sup>151</sup> so £5,000 may represent the total marginal cost, over five years, of the additional nursing care that is required when a DoC patient – who already requires constant care – is being treated with morphine.

The cost-effectiveness of the treatment would be significantly affected if the cost of neuroimaging were included. The marginal cost of a scan appears to be between £500 and £1,000.<sup>152</sup> £3,000 per patient therefore seems likely to cover the associated transport and other costs, as well as the scan itself. Incorporation of this into the above calculation leads to a cost per QALY for the same patient of £16,000, which would still meet NICE's criteria for cost-effectiveness. For many patients, however, neither life expectancy nor quality of life would be affected by having been assessed by neuroimaging. For such patients, there would be zero additional QALYs, meaning that the cost per QALY would be, theoretically,

---

<sup>149</sup> R Fraser, 'Taking care' (2014) NLJ 164, 13.

<sup>150</sup> J Silberman, 'Morphine: The cheap, effective pain-relief drug denied to millions' (2012) BBC News Magazine, 7 December.

<sup>151</sup> T Hughes-Hallett and others, Palliative Care Funding Review (2011). Online; <https://www.gov.uk/government/publications/independent-palliative-care-funding-review>, accessed 9 October 2014.

<sup>152</sup> Above n. 71 and n. 72.



infinite. Given the current state of neuroimaging techniques and their relative scarcity, therefore, it seems certain that, across the population of people with DoCs, a blanket neuroimaging programme would not be deemed cost-effective.

## CONCLUSION

It is difficult, but vitally important, to distinguish patients who are unconscious due to coma or being in VS from those who, because they either are in MCS or have LIS, have some awareness of themselves and the world. Misdiagnosis can lead to inappropriate treatment and inaccurate prognoses, and it carries the risk that those who are mistakenly classified as unconscious will undergo psychological suffering and treatable pain. It is therefore a matter for significant concern that some studies have suggested that approximately 40% of people diagnosed as being in VS are actually in MCS.

Several neuroimaging studies appear to have detected a degree of awareness in patients who, to all normal bedside observations, appear to be unconscious. At present, there are significant practical difficulties associated with fMRI, PET scanning and DTI and it does not seem realistic to recommend these for universal use amongst patients with DoCs in the near future. These difficulties do not apply to EEG, which some recent studies have suggested can discern signs of consciousness. fNRIS is also more practical than magnetic scanning; it may, potentially, offer some of the same opportunities for facilitating communication with visually unresponsive patients as does fMRI. Although the studies outlined above seem to have enormous potential, it is important that the science that underlies them should not be relied upon until it has been proved to be robust.

The ethical imperative of providing the best care to all patients requires regular re-assessment of patients with DoCs using the best methods available. At present, this seems to be a proven structured assessment tool such as the CRS–R, but within the next few years it may include at least one form of neuroimaging. Such re-assessments would enable the compilation of an accurate database of patients with DoCs, which is essential in order to ensure the provision of adequate specialised care facilities. Although there are valid ethical concerns about conducting research on patients who are unable to indicate their consent to it, it seems that the potential benefits to these patients – both individually and as a group – outweigh them.

Cases decided by the ECtHR indicate that Article 3 of the ECHR could include protection from both psychological suffering occasioned by incorrect diagnosis and physical pain that could be, but was not, treated. Article 3 is an absolute right, so conventional jurisprudence would suggest that Contracting States have an absolute duty to protect their citizens from these forms of suffering. The ECtHR has, however, been pragmatic about Contracting States' resources, and this consideration has also been evident in some cases decided in the UK courts.

In the UK, QALYs are used to determine whether treatments are clinically effective. For any individual patient in MCS, fMRI scanning might be cost-effective if it resulted in the administration of pain relief that very slightly improved the quality of that patient's life. Across the population of patients with DoCs, however, such assessment would certainly not be deemed effective at the current stage of knowledge. If future developments in any of the neuroimaging techniques had the effect of reducing cost, establishing reliability and thus leading to benefits for a significant percentage of patients, the situation could change dramatically. If this occurred, the UK – via its emanation, the NHS – could have an obligation under human rights treaties to undertake regular neuroimaging re-assessments of all patients with DoCs, and

to attempt to facilitate communication with those who were in MCS or total LIS but unable to communicate by conventional means. One would hope that anything that could reduce the risk of any unnecessary suffering by these extremely vulnerable people would be offered without their needing to resort to the law in order to enforce their human rights.